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ABSTRACT

A computerized faculty allocation and reallocation model is presented to aid the decision maker in evaluating the outcomes of various strategies. A unique goal can be computed for each department based on the average index of the institution, the average of the college, the preceding average of the department, and a goal established by management for the department. The relative importance of these four factors can be set separately for each department. The model seeks to compare a department with itself or, if desired, with its college or the university as a whole: furthermore, one may place a goal on the college. The algorithm then permits weights to be placed on the comparison variables (for example, the college or university) and decisions made on how fast an overstaffed department converges toward the objective and in the process of converging what proportion of faculty are returned. The overstaffed full-time-equivalent faculty positions are accumulated and can be distributed with any new positions to the understaffed departments. The model uses iteration to simulate several years. This model, which enables a decision maker to review several variables to derive an overall strategy for faculty allocation, simulates factors involved in the allocation of faculty while leaving the decision maker to determine a unique workload goal for each department. Brief consideration is given to the following additional approaches: costing approach, faculty approach based on a state formula allocation, and department level allocations. (SW)

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Planning and Management of Faculty Resources

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Abstract

A computerized faculty allocation and reallocation model is presented which will aid the decision maker in evaluating the outcomes of various strategies. A unique goal can be computed for each department based on the average index of the institution, the average of the college, the preceding average of the department, and a goal established by management for the department. The relative importance of these four factors can be set separately for each department. In addition, the proportion of "overstaffed" faculty who are reallocated can be controlled by the decision maker. The model uses iteration to simulate several years.

THE ASSOCIATION FOR INSTITUTIONAL RESEARCH

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(Editor, AIR Forum Publications)

Planning and Management of Faculty Resources

Institutions continually face the need to reallocate resources among their programs as a result of limited resources and shifting student demand. Two major approaches exist to allocate resources: dollars needed or faculty needed. While the two are related, the faculty required approach appears the least complicated at the institutional level. In this paper we argue the faculty required approach is more relevant since dollars do not produce outcomes, people do. While the following paper briefly discusses one procedure to reallocate based on cost, the primary focus is on the question of allocation of faculty positions. In addition, the intent is to demonstrate a decision tool which can be used when departments are expected to have different levels of activity in terms of a single output measure (for example, student credit hours taught) and which can take into account local differences and policy preferences.

Costing approach. One can undertake a cost study, predict the number of student credit hours (or other units of activity), and multiply predicted student credit hours by the unit cost of a course to derive a new dollar figure. This procedure is extremely complicated, however, and probably not sufficiently refined to highlight areas where reallocation should take place. An example follows:

	SCH Lower Div	SCH Upper Div	Cost per Hr. Lower Div	Cost per Hr Upper Div	Projected SCH Lower	Projected SCH Upper
Biology	1,000	100	$50	$125	1,200	100
Engineering	1,000	100	$100	$250	1,000	325

Projected Biology 1,200 x $50 + 100 x $125 = $72,500

Projected Engineering 1,000 x $100 + 325 x $250 = $181,250

While the formula given here is simple, the collection of dollars

per credit hour is complex--depending in part on what direct and indirect costs are used. A cost model can be used to allocate resources to departments, but in actuality other procedures which are more easily derived are generally used. (For an excellent overview of cost models, see Sheehan and Gulko, 1976 and Adams, et al. 1978).

Faculty Approach. At an even higher level of aggregation, Brown (1979) reviews an allocation model based on a state formula allocation. Since the vast majority of state colleges and universities receive part of their monies through a formula funding system, perhaps a brief review of this procedure and why it does not work for faculty allocation on an individual campus is needed.

A state formula typically uses student credit hours by level to derive number of faculty needed to teach these hours. The resulting figures are then expressed in number of faculty required or in average dollars required to fund one full-time equivalent faculty (FTEF) member. Here is how a simplified system might work.

Assume that 300 lower-division student credit hours = 1 allocated faculty. (Student credit hours are derived by multiplying section enrollment by the credit value of a course.)

Assume that 200 upper-division student credit hours = 1 allocated faculty. One then computes the funded faculty as shown in Table I.

Table 1

Department	Lower Div. Credit Hrs	Upper Div. Credit Hrs	Lower Div. Fac. By Formula	Upper Div. Fac. By Formula	No. of Actual Faculty
Biology	1,000	100	3.33	.5	1.5
Engineering	1,000	100	3.33	.5	6.0
			6.66	1.0	7.5

While the funding formula for these two departments has allocated 7.66 positions, the University may have actually employed 7.5 faculty members and in a way different from the formula. The potential weakness or problem with using the funding formula to make internal allocations becomes obvious. Biology, which without doubt will prove more than willing to add 2.33 positions, has been teaching its SCH with less; Engineering, which will argue that small classes and technical training require greater resources, has acquired more resources than the formula permits. Since these over and under figures can be expected to appear for departments throughout the university, the chief academic officer given information on the "earned" positions by department will, if at all gifted, throw the information away as being useless for rational decision making. Those who do not will soon realize that they have abdicated a major part of their responsibility to state agencies. Yet, some type of numerical assistance might help, especially if the manager could tailor it to his/her university. After all, one should replace the department head who can not make a good case, with or without substantive data, to add faculty members; meanwhile, managers need some base line against which to measure correctness of these pleas.

This paper, incidentally, only tangentially concerns measuring faculty workload; however, we assume that an institution has developed some overall index to measure the effort a faculty member uses to teach a class, engage in advising, undertake committee assignments, and spend in related matters. Measuring faculty workload has previously been addressed and needs no further development herein (see, for example, the useful study by John Stecklein, 1974).

Dressel and Simon (1976) in Allocating Resources Among Departments provide many useful and necessary insights into this type of resource

allocation. Student credit hours, these authors observe, have been incorporated into the state-wide allocation of funds through various formula funding procedures. Rather naturally these student credit hours and formula are at times used to make department allocations. One immediate problem, however, with such usage is that SCHs do not necessarily relate uniformly to effort requirements of faculty to teach the SCHs. Another problem is that student credit hour assignments (loads) of faculty in various disciplines have tended to differ nationally. Dressel and Simon, commenting on the reluctance of department heads to use formulas, state: "The application of formulas to university and departmental budgeting probably has much more merit than many administrators or faculty members will admit." (Dressel and Simon, 1976, p. 21)

Hopkins (1974), who might be considered among the foremost in developing models for colleges and universities, has provided an instructive mathematical model for faculty flow. His model allows one to see what happens to faculty needs when one alters such variables as percent of faculty tenured, retirement policies, and promotion procedures. His model can be used to project salaries and the results of employing various strategies in the mix of faculty employed. Several authors have expanded the procedure (for example, see Bottomley, et al., 1980; Spinney and McLaughlin, 1979; Gray, 1980; Linnell, 1976). As a macro model, Hopkins' approach does not purport to show, however, where faculty might be placed to assure a somewhat equitable teaching load within a department--the topic of this paper is a micro model which has an immediate utility for decision making.

Department level allocations. While various ways exist to make resource allocations to departments, the following are examples which have some numerical basis. Even though chief academic officers may not formally use one or more of these procedures, they may informally do so.

Section to faculty approach.

No. of sections taught in Biology	No. of Faculty teaching Biology
(A)	(B)
13	1.5

To find faculty needs, one assumes:

(A : B) as (No. of sections projected to be taught: No. of faculty needed), or Number of faculty needed = (B/A) * Projected number of sections. This procedure, while not necessarily formalized, will work, especially in smaller institutions. The problem, however, is that in declining enrollments, the number of sections may remain constant; conversely, growing departments, if faculty are not added, force more students into existing sections or limit enrollment per section. Section size, therefore, becomes a missing part of many modeling equations; the next example corrects for section size.

SCH to faculty approach.

SCH taught in Biology	No. of Faculty
(A)	(B)
1,100	1.5

Here one assumes:

(A : B) as (Projected Biology SCH : Number of faculty needed) or Number of faculty needed = (B/A) * Projected SCH. By using the ratio above by level of course (lower and upper), one accomplishes more refinement.

Another approach is to use the following formula (Sheehan and Gulko, 1976, p. 63).

Number of faculty needed =

$$\frac{\text{Number of Students x Average Student Load}}{\text{Average Class Size x Average Faculty Load}}$$

where the number of students and average student load are estimated and the remaining variables are set by policy or prior experience. The SCH to faculty ratios used above are simple and compare a department with itself. When looking for alternative numerical allocation procedures, one would be well advised to weigh whether the results obtained equal the effort. The main problem with the SCH to faculty ratio procedures is in trying to spot increases or decreases in SCH over time and to correct historical overstaffing or understaffing of faculty which has resulted from a larger increase in students than faculty or a drop in students but no decline in faculty. This problem reflects a need to consider variations in how credit hours are generated across departments, for example, use of large lecture sections in one department versus numerous seminars in another course. It also reflects a need to balance what has traditionally occurred in the institution and the department with what the manager feels is an ideal goal for a specific department.

One of the more comprehensive departmental resource review procedures has been developed at Michigan State where analysts collect several indicators of departmental efforts and then prepare written comments on departmental needs (Dressel and Simon, 1976). These analysts use indicators such as the following:

a. Staffing information. Here one finds number of faculty, SCH/FTE teaching faculty index, organized class contact hours/FTETF,[1] and average section size by level.

b. Staff flexibility relative to tenure. Here one finds information on tenured and non-tenured faculty members.

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[1]Full Time Equivalent Teaching Faculty

c. Enrollments. These data include six years of information on total SCH, SCH/FTETF, class hours/FTETF, average section size, and number of majors.

d. Professional outputs. This section reviews professional accomplishment such as published output/FTE research faculty or major professional activities/FTERF.

While the Michigan State allocation system contains many other factors, for example, curricular aspirations or new program plans, suffice it to say here that the indicators used provide a good basis for numerical analyses which can be used in the decision making process of a chief academic officer. We believe the approach used in Michigan State is effective; procedures such as those described in this paper add certain simulation procedures to enhance such analyses.

Department Workload Model. The model herein proposed searches for apparent "understaffed" or "overstaffed" departments while seeking to control for some of the inherent difficulties associated with such modeling. Specifically, the model using internal and historical figures computes a workload objective[2] for each department. This objective is based on the weighted combination of the overall average productivity at the institution, the average productivity of the college, the traditional[2] (three-year average) productivity of the department, and the ideal productivity or goal of the department. Since the weights as well as the unique history can vary by department, the departmental objectives can be different. The model moves toward the departmental target with

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[2]The underlined modifiers of workload have specific meanings in this paper and are not to be interpreted as synonyms. See Appendix for definitions.

a proportion of the overstaffed faculty being reallocated each iteration and the objective recomputed for each department for each iteration. The iterations represent yearly time periods and allow for investigating the implications of various policies. This model, which causes a decision maker to review several variables to derive an overall strategy for faculty allocation, simulates factors involved in the allocation of faculty while leaving the decision maker to determine a unique workload goal for each department. For an overview of the steps, see Figure 1.

Step 1. The following data for departments are used.

a. Weighted Student Credit Hours (WSCH) for past three years. Our model used the following weights by course level: Lower level 1.00; Upper level 1.67; Graduate I 2.50; and Graduate II 3.12. The weights can be varied to accommodate state formula weights, internal weights, or replaced by SCHs.

b. Full time equivalent faculty (FTEF) positions allocated (includes allocated graduate assistantships)--data for 3 years.

c. Projected WSCH by department for 10 years.

Step 2. Apply the following formula to find the department tradition.

$$\text{Department Tradition} = \frac{\text{Historical Year 1 } \frac{\text{WSCH}}{\text{FTEF}} + \text{Historical Year 2 } \frac{\text{WSCH}}{\text{FTEF}} + \text{Historical Year 3 } \frac{\text{WSCH}}{\text{FTEF}}}{3}$$

The departmental three-year index (tradition) will give a figure in the neighborhood of 100 to 500 for most universities on the quarter system and 300 to 1,500 if one uses a yearly basis for data.

Step 3. Select weights for the variables which will move the faculty allocations in the desired direction. Simple models fail at this point,

for they tend to compare a department with a college or university average workload when the comparison should be against itself or like departments. Such a deficiency can be overcome by the manager controlling the value of the variables, for example, whether to maintain the historical status quo or develop a need for faculty which is influenced by relative standing in the college and university. This model permits four weights to be given. The following is an illustration:

D = Weight for Department Tradition .3

C = Weight for College .2

U = Weight for University .2

G = Ideal goal weight for Department .3

The weighting scheme in this example favors the historical teaching/workload pattern of the department (.3), the ideal goal for the department (.3), with the college and university patterns (.2 and .2 respectively) receiving the remainder of the weight. In such a situation, the manager has decided that the workload of both the college and the university must be considered when ascribing faculty to this department.

As noted earlier, the goal is the ideal toward which management wants the department to move. The figure might be between 100 and 500 WSCH a quarter; it can be computed by multiplying the ideal number of courses by the preferred average enrollment for each class. By specifying a value for the goal and assigning it a weight, one ameliorates the influence of historical workloads within the institution.

Step 4. The next step in the model uses the weights from Step 3 to derive an appropriate workload objective for the department. This step also provides the number of faculty which "ideally" is needed for the department to be at that objective in the next year of operation. The procedure follows:

Department Objective = Department Tradition

+ C x College Average for current year

+ U x University Average for current year

+ G x Ideal Goal, i.e., figure from management.

Using the Biology Department as our example, one now assembles data, such as those in the Appendix, and solves the formulas to find the department objective (837 WSCH/FTEF).

Step 5. The next formula divides the projected WSCH for next year by the FTE faculty in the current year: $\frac{\text{Projected WSCH}}{\text{FTEF}}$

The resulting figure shows what would occur if no change is made in staffing. In the program this step is called Estimated and displays what will happen to the department if faculty staffing stays constant--given the projected student credit hours. From the example in the appendix, one finds:

$$\text{Estimated} = \frac{12{,}000 \text{ Projected WSCH}}{15 \text{ FTEF}} = 800$$

Step 6. One is now prepared to adjust staffing by determining a rate of change in staffing over time. For overstaffed departments the manager can enter a figure for Variable A which establishes such a rate. One finds convergence or Variable A as follows: $1 - \frac{1}{\text{Yrs to Convergence}}$

In the Appendix Variable A is set at .3--a zero would bring convergence at once and a one brings no movement. While Variable A establishes a time for convergence for overstaffed departments, Variable B serves the same function for an understaffed department. Both variables would probably be given the same value; however, the manager can vary them. Variable A is used in Step 6 to adjust how far the Estimated WSCH/FTEF in Step 5 will be adjusted toward the Objective: Adjusted Target = Objective + A(Estimated - Objective).

Step 7. In addition to the Adjusted Target from Step 6, one also has the option to use a Return Variable (RTN) to permit the manager to establish what part of any remaining faculty overage or deficiency is returned or gained in that year. Again one enters any figure from 0 to 1.0, with a 0 causing all the loss or gain to be shown in the year under consideration. What happens can be graphically displayed as follows:

When a department is overstaffed

Retained by Variable A-Rate of Convergence (P-1)	Retained by RTN Variable (P-2)	Returned to University (P-3)

The Return Variable is used in Step 7a and 7b to find the number of faculty needed and the department workload anticipated.

Step 7a. Department Faculty Anticipated =

$$\text{FTEF} - A\left(\text{FTEF} - \frac{\text{Projected WSCH for Current Year}}{\text{Adjusted Target}}\right)$$

Step 7b. Department Workload Anticipated =

$$\frac{\text{Projected WSCH for Current Year}}{\text{Department Faculty Anticipated}}$$

Step 8. The actual number of positions added to an understaffed department is dependent on the department's need relative to the total positions available. The formula for Step 8 is the same as used in 7a except that Variable B is substituted for A. The result provides the number of faculty which "should" be added.

Step 9. When the number of positions are returned from the overage (P-3) and any new positions added which the institution has acquired from additional funding or other external sources, these faculty positions are then allocated to the understaffed departments.

When a department needs faculty

No. needed but not added in nth year (N-1)	No. added in nth year (N-2)

A department, however, receives additional staffing based on its needs relative to the positions available. This step usually brings a lesser allocation.

Step 10. The data from Step 7 are accumulated to find the overall overage for faculty positions and the new FTEF number for the department; the results from Steps 7 through 9 become a part of the three-year average for the department in the Objective for the next year. With the WSCH projection obtained from other sources one is now ready for the next iteration of the algorithm. The model reports summary statistics for the institution as well as information on each department and college.

Summary

The purpose of this departmental model exercise is to cause the decision maker to review some of the factors involved in faculty allocation. Naturally, such a person will not be concerned with fractional positions to add or delete in a given year. When larger numbers accumulate and trends are evident, however, the manager has supporting material to aid in a decision. The model seeks to compare a department with itself or if desired with its college or the university as a whole; furthermore, one may place a goal on the college. The algorithm then permits weights to be placed on the comparison variables (for example, the college or the university) and decisions made on how fast an overstaffed department converges toward the objective and in the process of converging what proportion of faculty are returned. The overstaffed FTEF positions are accumulated and can be distributed with any new positions to the understaffed departments. The algorithm does not replace the manager; it can be used as that person considers alternatives.

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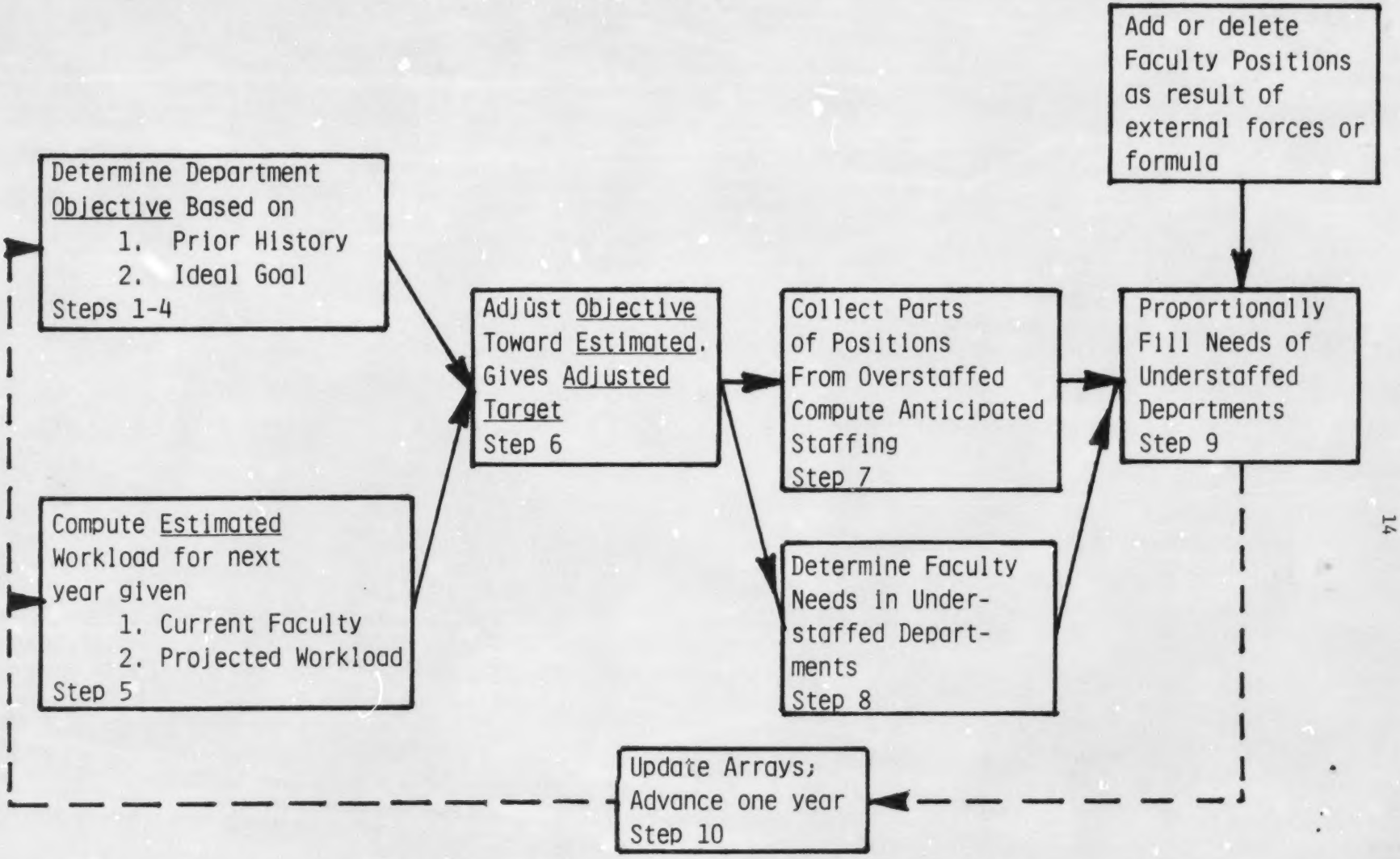
Add or delete Faculty Positions as result of external forces or formula
Determine Department Objective Based on
1. Prior History
2. Ideal Goal
Steps 1-4
Adjust Objective Toward Estimated. Gives Adjusted Target
Step 6
Collect Parts of Positions From Overstaffed Compute Anticipated Staffing
Step 7
Proportionally Fill Needs of Understaffed Departments
Step 9
Compute Estimated Workload for next year given
1. Current Faculty
2. Projected Workload
Step 5
Determine Faculty Needs in Understaffed Departments
Step 8
Update Arrays; Advance one year
Step 10

Figure 1. Steps in the Departmental Model

Appendix

Definitions Used

Workload		Definition
(1)	Goal	Ideal level of activity set by management
(2)	Tradition	Average of last 3 years
(3)	Objective	Weighted combination of WSCH from department, college, and university
(4)	Estimated	What the workload will be if the projected activity level is divided by current staffing
(5)	Adjusted Target	Preferred workload after adjusting for relative weight given estimated workload
(6)	Anticipated	What the workload is anticipated to be, given the projected activity level is divided by the adjusted staffing

Example

An Overstaffed Department

1. Historical data

Projected WSCH for Biology (1981-82)	12,000
WSCH for Biology (1980-81)	11,670
University Average (1980-81)	800 WSCH/FTEF
Arts & Science (1980-81)	870 WSCH/FTEF
Biology (traditional)	778 WSCH/FTEF
FTEF in Biology (1980-81)	15

2. Control (Policy Variables)

D = Weight for Biology Tradition	= .3
C = Weight for College	= .2
U = Weight for University	= .2
G = Goal weight for Biology	= .3
Management Goal for Biology (WSCH/FTEF)	= 900

Variable A = a factor which permits one to allow more than one year for a department to converge on its objective. For example .3. The program specifies A for overstaffed and B for understaffed departments.

RTN = for overstaffed departments (based on Variable A), proportion of overstaffed faculty returned for reallocation = .5

New faculty positions added to the university pool for 1981-82 = 3.0

3. Computations (Biology)

Workload:

Step 4 Objective = .3(778) + .2(870) + .2(800) + .3(900) = 837

Step 5 Estimated = (12,000/15) = 800

Step 6 Adjusted Target = 837 + .3(800 - 837) = 826

Step 7a Dept. Faculty Anticipated = 15 - .5(15 - 12,000/826) = 15 - .5(.47) = 14.76

7b Dept. Workload Anticipated = 12,000/14.76 = 813